



March 1995  
Revised February 2004

## 74LCX138 Low Voltage 1-of-8 Decoder/Demultiplexer with 5V Tolerant Inputs

### General Description

The LCX138 is a high-speed 1-of-8 decoder/demultiplexer. This device is ideally suited for high-speed memory chip select address decoding. The multiple input enables allow parallel expansion to a 1-of-24 decoder using just three LCX138 devices or a 1-of-32 decoder using four LCX138 devices and one inverter.

The 74LCX138 is fabricated with advanced CMOS technology to achieve high speed operation while maintaining CMOS low power dissipation.

### Features

- 5V tolerant inputs
- 2.3V to 3.6V  $V_{CC}$  specifications provided
- 6.0 ns  $t_{PD}$  max ( $V_{CC} = 3.3V$ ), 10  $\mu A$   $I_{CC}$  max
- Power down high impedance inputs and outputs
- $\pm 24$  mA output drive ( $V_{CC} = 3.0V$ )
- Implements patented noise/EMI reduction circuitry
- Latch-up performance exceeds 500 mA
- ESD performance:
  - Human body model > 2000V
  - Machine model > 200V
- Leadless DQFN package

### Ordering Code:

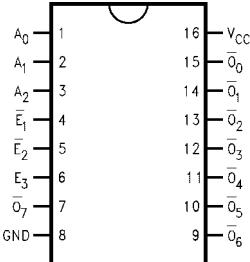
Order Number	Package Number	Package Description
74LCX138M (Note 1)	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
74LCX138SJ (Note 1)	M16D	16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
74LCX138BQX (Note 2)	MLP016E	16-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 3.5mm
74LCX138MTC (Note 1)	MTC16	16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide

Note 1: Devices also available in Tape and Reel. Specify by appending suffix letter "X" to the ordering code.

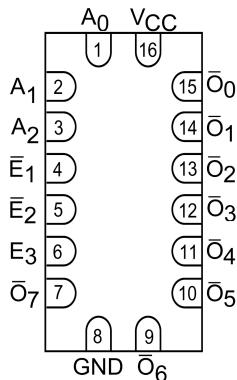
Note 2: DQFN package available in Tape and Reel only.

## Connection Diagrams

### Pin Assignments for SOIC, SOP, and TSSOP



### Pad Assignments for DQFN



(Top Through View)

## Pin Descriptions

Pin Names	Description
A <sub>0</sub> –A <sub>2</sub>	Address Inputs
Ē <sub>1</sub> –Ē <sub>2</sub>	Enable Inputs
E <sub>3</sub>	Enable Input
Ō <sub>0</sub> –Ō <sub>7</sub>	Outputs

## Functional Description

The LCX138 high-speed 1-of-8 decoder/demultiplexer accepts three binary weighted inputs (A<sub>0</sub>, A<sub>1</sub>, A<sub>2</sub>) and, when enabled, provides eight mutually exclusive active-LOW outputs (Ō<sub>0</sub>–Ō<sub>7</sub>). The LCX138 features three Enable inputs, two active-LOW (Ē<sub>1</sub>, Ē<sub>2</sub>) and one active-HIGH (E<sub>3</sub>). All outputs will be HIGH unless Ē<sub>1</sub> and Ē<sub>2</sub> are LOW and E<sub>3</sub> is HIGH. The LCX138 can be used as an 8-output demultiplexer by using one of the active LOW Enable inputs as the data input and the other Enable inputs as strobes. The Enable inputs which are not used must be permanently tied to their appropriate active-HIGH or active-LOW state.

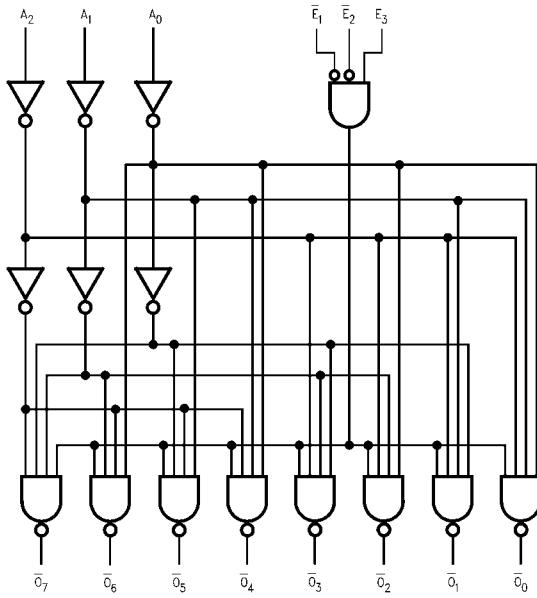
## Truth Table

Inputs						Outputs							
Ē <sub>1</sub>	Ē <sub>2</sub>	E <sub>3</sub>	A <sub>0</sub>	A <sub>1</sub>	A <sub>2</sub>	Ō <sub>0</sub>	Ō <sub>1</sub>	Ō <sub>2</sub>	Ō <sub>3</sub>	Ō <sub>4</sub>	Ō <sub>5</sub>	Ō <sub>6</sub>	Ō <sub>7</sub>
H	X	X	X	X	X	H	H	H	H	H	H	H	H
X	H	X	X	X	X	H	H	H	H	H	H	H	H
X	X	L	X	X	X	H	H	H	H	H	H	H	H
L	L	H	L	L	L	L	H	H	H	H	H	H	H
L	L	H	H	L	L	H	L	H	H	H	H	H	H
L	L	H	L	H	L	H	H	L	H	H	H	H	H
L	L	H	H	H	L	H	H	H	L	H	H	H	H
L	L	H	L	H	H	H	H	H	H	L	H	H	H
L	L	H	H	H	H	H	H	H	H	H	L	H	H
L	L	H	H	H	H	H	H	H	H	H	H	H	L

H = HIGH Voltage Level

L = LOW Voltage Level

X = Immaterial

**Logic Diagram**

Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

**Absolute Maximum Ratings**(Note 3)

Symbol	Parameter	Value	Conditions	Units
$V_{CC}$	Supply Voltage	-0.5 to +7.0		V
$V_I$	DC Input Voltage	-0.5 to +7.0		V
$V_O$	DC Output Voltage	-0.5 to $V_{CC}$ + 0.5	Output in HIGH or LOW State (Note 4)	V
$I_{IK}$	DC Input Diode Current	-50	$V_I < GND$	mA
$I_{OK}$	DC Output Diode Current	-50 +50	$V_O < GND$ $V_O > V_{CC}$	mA
$I_O$	DC Output Source/Sink Current	$\pm 50$		mA
$I_{CC}$	DC Supply Current per Supply Pin	$\pm 100$		mA
$I_{GND}$	DC Ground Current per Ground Pin	$\pm 100$		mA
$T_{STG}$	Storage Temperature	-65 to +150		°C

**Recommended Operating Conditions** (Note 5)

Symbol	Parameter	Min	Max	Units
$V_{CC}$	Supply Voltage	Operating Data Retention	2.0 1.5	3.6 3.6
$V_I$	Input Voltage		0.0	5.5
$V_O$	Output Voltage	HIGH or LOW State	0.0	$V_{CC}$
$I_{OH}/I_{OL}$	Output Current	$V_{CC} = 3.0V$ to 3.6V $V_{CC} = 2.7V$ to 3.0V $V_{CC} = 2.3V$ to 2.7V		±24.0 ±12.0 ±8.0
$T_A$	Free-Air Operating Temperature		-40.0	85.0
$\Delta t/\Delta V$	Input Edge Rate, $V_{IN} = 0.8V$ to 2.0V, $V_{CC} = 3.0V$		0.0	10.0
				ns/V

**Note 3:** The Absolute Maximum Ratings are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the Absolute Maximum Ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

**Note 4:**  $I_O$  Absolute Maximum Rating must be observed.

**Note 5:** Unused inputs must be held HIGH or LOW. They may not float.

**DC Electrical Characteristics**

Symbol	Parameter	Conditions	$V_{CC}$ (V)	$T_A = -40^{\circ}C$ to $+85^{\circ}C$		Units
				Min	Max	
$V_{IH}$	HIGH Level Input Voltage		2.3 to 2.7	1.7		V
			2.7 to 3.6	2.0		
$V_{IL}$	LOW Level Input Voltage		2.3 to 2.7		0.7	V
			2.7 to 3.6		0.8	
$V_{OH}$	HIGH Level Output Voltage	$I_{OH} = -100 \mu A$	2.3 to 3.6	$V_{CC} - 0.2$		V
		$I_{OH} = -8 mA$	2.3	1.8		
		$I_{OH} = -12 mA$	2.7	2.2		
		$I_{OH} = -18 mA$	3.0	2.4		
		$I_{OH} = -24 mA$	3.0	2.2		
$V_{OL}$	LOW Level Output Voltage	$I_{OL} = 100 \mu A$	2.3 to 3.6		0.2	V
		$I_{OL} = 8mA$	2.3		0.6	
		$I_{OL} = 12 mA$	2.7		0.4	
		$I_{OL} = 16 mA$	3.0		0.4	
		$I_{OL} = 24 mA$	3.0		0.55	
$I_I$	Input Leakage Current	$0 \leq V_I \leq 5.5V$	2.3 to 3.6		±5.0	µA
$I_{OFF}$	Power-Off Leakage Current	$V_I$ or $V_O = 5.5V$	0.0		10.0	µA
$I_{CC}$	Quiescent Supply Current	$V_I = V_{CC}$ or GND	2.3 to 3.6		10.0	µA
		$3.6V \leq V_I \leq 5.5V$	2.3 to 3.6		±10.0	
$\Delta I_{CC}$	Increase in $I_{CC}$ per Input	$V_{IH} = V_{CC} - 0.6V$	2.3 to 3.6		500	µA

## AC Electrical Characteristics

Symbol	Parameter	$T_A = -40^\circ\text{C to } +85^\circ\text{C}, R_L = 500\Omega$						Units	
		$V_{CC} = 3.3\text{V} \pm 0.3\text{V}$		$V_{CC} = 2.7\text{V}$		$V_{CC} = 2.5\text{V} \pm 0.2\text{V}$			
		$C_L = 50\text{pF}$		$C_L = 50\text{pF}$		$C_L = 30\text{pF}$			
		Min	Max	Min	Max	Min	Max		
$t_{PHL}$	Propagation Delay An to $\overline{Qn}$	1.5	6.0	1.5	7.0	1.5	7.2	ns	
$t_{PLH}$	Propagation Delay E3 to $\overline{Qn}$	1.5	6.5	1.5	7.5	1.5	8.4	ns	
$t_{PHL}$	Propagation Delay $\overline{E1}$ or $\overline{E2}$ to $\overline{Qn}$	1.5	6.0	1.5	7.0	1.5	7.2	ns	
$t_{OSHL}$	Output to Output Skew (Note 6)		1.0					ns	
$t_{OSLH}$			1.0						

**Note 6:** Skew is defined as the absolute value of the difference between the actual propagation delay for any two separate outputs of the same device. The specification applies to any outputs switching in the same direction, either HIGH-to-LOW ( $t_{OSHL}$ ) or LOW-to-HIGH ( $t_{OSLH}$ ).

## Dynamic Switching Characteristics

Symbol	Parameter	Conditions		$V_{CC}$ (V)	$T_A = 25^\circ\text{C}$	Units
					Typical	
$V_{OLP}$	Quiet Output Dynamic Peak $V_{OL}$	$C_L = 50\text{ pF}, V_{IH} = 3.3\text{V}, V_{IL} = 0\text{V}$	$C_L = 30\text{ pF}, V_{IH} = 2.5\text{V}, V_{IL} = 0\text{V}$	3.3	0.8	V
$V_{OLV}$	Quiet Output Dynamic Valley $V_{OL}$	$C_L = 50\text{ pF}, V_{IH} = 3.3\text{V}, V_{IL} = 0\text{V}$	$C_L = 30\text{ pF}, V_{IH} = 2.5\text{V}, V_{IL} = 0\text{V}$	3.3	-0.8	V

## Capacitance

Symbol	Parameter	Conditions	Typical	Units
$C_{IN}$	Input Capacitance	$V_{CC} = \text{Open}, V_I = 0\text{V}$ or $V_{CC}$	7.0	pF
$C_{OUT}$	Output Capacitance	$V_{CC} = 3.3\text{V}, V_I = 0\text{V}$ or $V_{CC}$	8.0	pF
$C_{PD}$	Power Dissipation Capacitance	$V_{CC} = 3.3\text{V}, V_I = 0\text{V}$ or $V_{CC}, f = 10\text{ MHz}$	25.0	pF

## AC Loading and Waveforms Generic for LCX Family

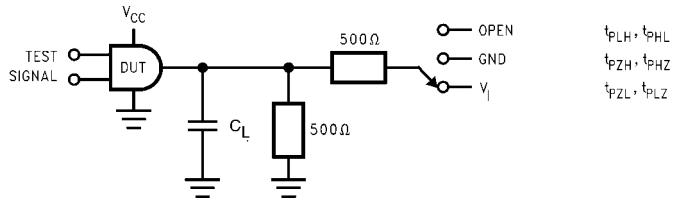
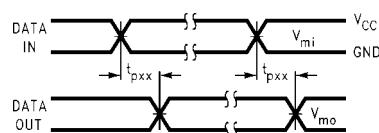
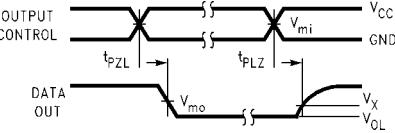


FIGURE 1. AC Test Circuit  
( $C_L$  includes probe and jig capacitance)

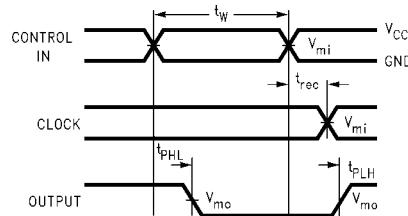
Test	Switch
$t_{PLH}, t_{PHL}$	Open
$t_{PZL}, t_{PLZ}$	6V at $V_{CC} = 3.3V \pm 0.3V$ $V_{CC} \times 2$ at $V_{CC} = 2.5V \pm 0.2V$
$t_{PZH}, t_{PHZ}$	GND



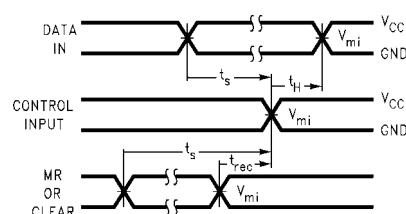
Waveform for Inverting and Non-Inverting Functions



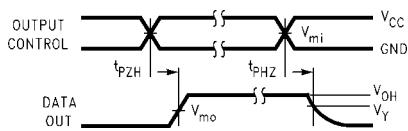
3-STATE Output Low Enable and  
Disable Times for Logic



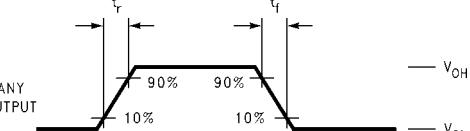
Propagation Delay, Pulse Width and  $t_{rec}$  Waveforms



Setup Time, Hold Time and Recovery Time for Logic



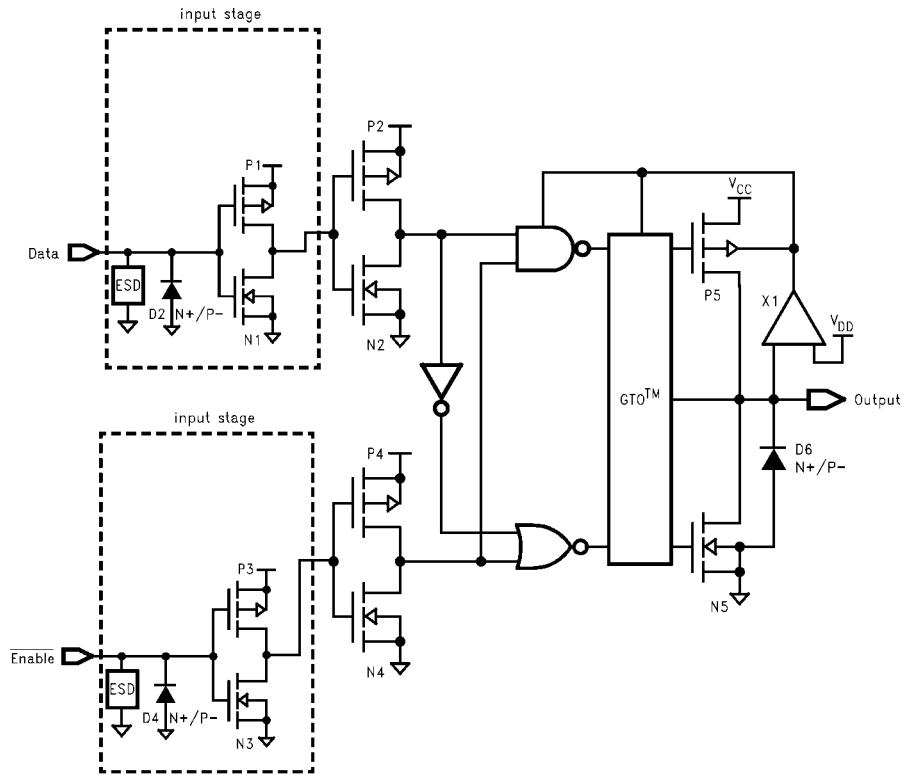
3-STATE Output High Enable and  
Disable Times for Logic



$t_r$  and  $t_f$

Symbol	$V_{CC}$		
	$3.3V \pm 0.3V$	$2.7V$	$2.5V \pm 0.2V$
$V_{mi}$	1.5V	1.5V	$V_{CC}/2$
$V_{mo}$	1.5V	1.5V	$V_{CC}/2$
$V_x$	$V_{OL} + 0.3V$	$V_{OL} + 0.3V$	$V_{OL} + 0.15V$
$V_y$	$V_{OH} - 0.3V$	$V_{OH} - 0.3V$	$V_{OH} - 0.15V$

FIGURE 2. Waveforms  
(Input Pulse Characteristics;  $f = 1MHz$ ,  $t_r = t_f = 3ns$ )

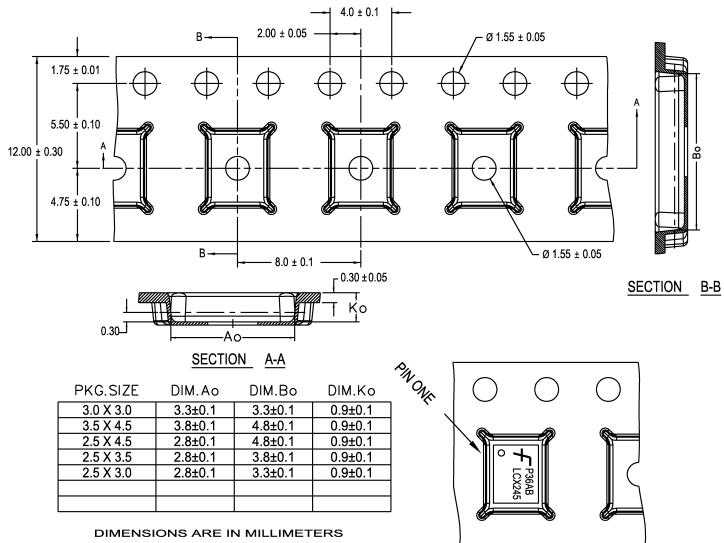
**Schematic Diagram** Generic for LCX Family

## Tape and Reel Specification

### Tape Format for DQFN

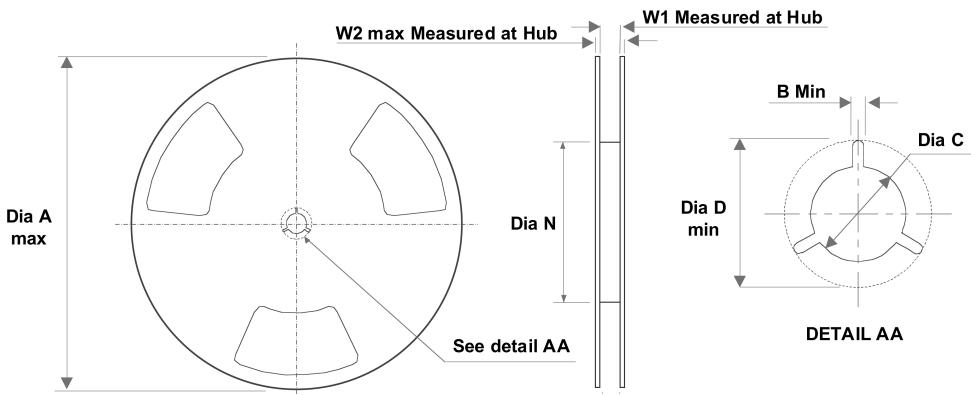
Package Designator	Tape Section	Number Cavities	Cavity Status	Cover Tape Status
BQX	Leader (Start End)	125 (typ)	Empty	Sealed
	Carrier	3000	Filled	Sealed
	Trailer (Hub End)	75 (typ)	Empty	Sealed

### TAPE DIMENSIONS inches (millimeters)



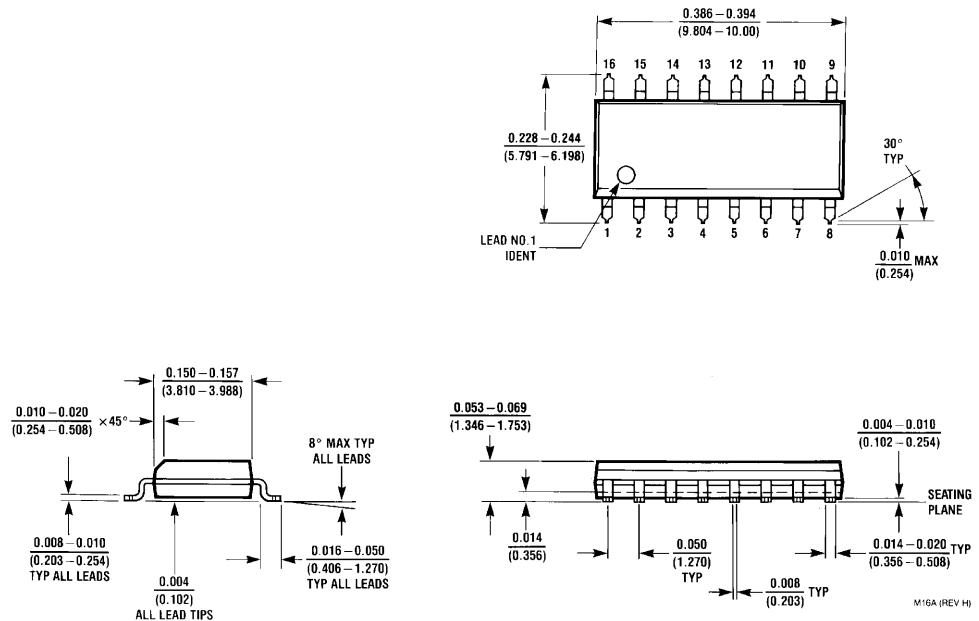
### FSC MLP/DQFN CARRIER TAPE SPECIFICATIONS

### REEL DIMENSIONS inches (millimeters)



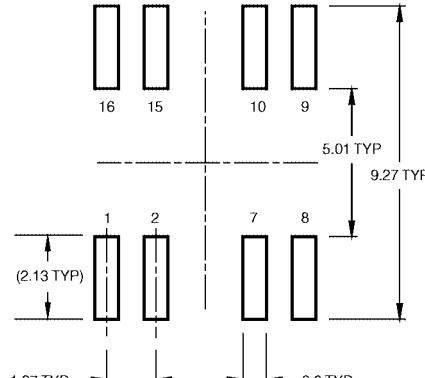
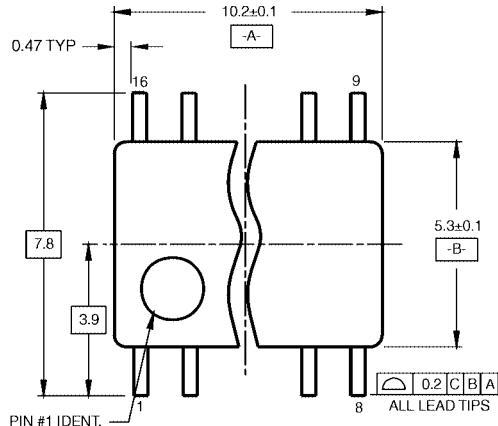
Tape Size	A	B	C	D	N	W1	W2
12 mm	13.0 (330.0)	0.059 (1.50)	0.512 (13.00)	0.795 (20.20)	2.165 (55.00)	0.488 (12.4)	0.724 (18.4)

**Physical Dimensions** inches (millimeters) unless otherwise noted

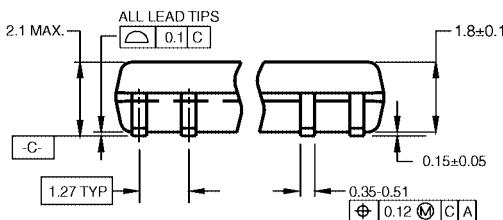


16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow  
Package Number M16A

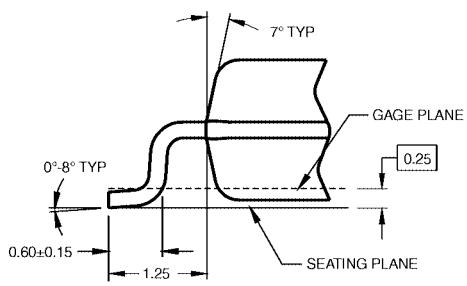
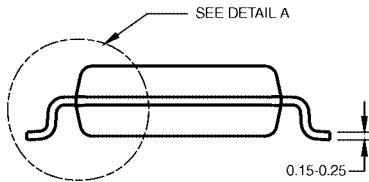
## **Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



#### LAND PATTERN RECOMMENDATION



DIMENSIONS ARE IN MILLIMETERS



## NOTES:

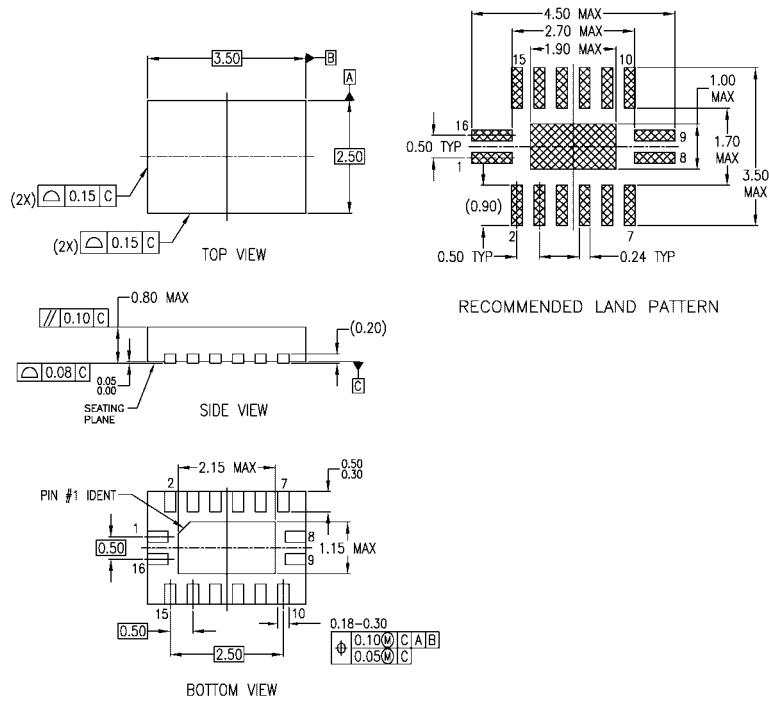
NOTES:

- A. CONFORMS TO EIAJ EDR-7320 REGISTRATION, ESTABLISHED IN DECEMBER, 1998.
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.

M16DRevB1

**16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide  
Package Number M16D**

### Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



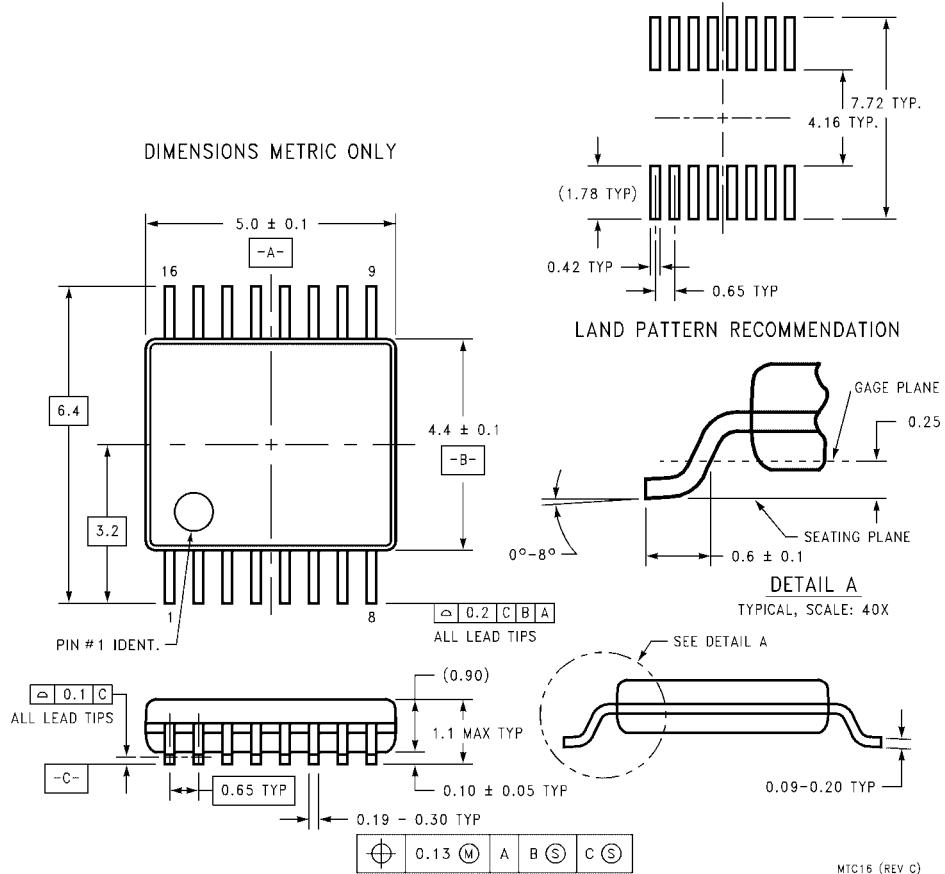
#### NOTES:

- A. CONFORMS TO JEDEC REGISTRATION MO-241, VARIATION AB
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994

MLP016ErevA

16-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 3.5mm  
Package Number MLP016E

**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide  
Package Number MTC16

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